

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
27 March 2003 (27.03.2003)

PCT

(10) International Publication Number
WO 03/024380 A1

(51) International Patent Classification⁷: **A61G 7/057**

(21) International Application Number: PCT/GB02/04233

(22) International Filing Date:
18 September 2002 (18.09.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0122764.4 21 September 2001 (21.09.2001) GB

(71) Applicants and

(72) Inventors: **CALDWELL, Kenneth** [GB/GB]; Horn Hill House, Beaminster, Dorset DT8 3PT (GB). **CALDWELL, Kevin, Michael** [GB/GB]; Horn Hill House, Beaminster, Dorset DT8 3PT (GB).

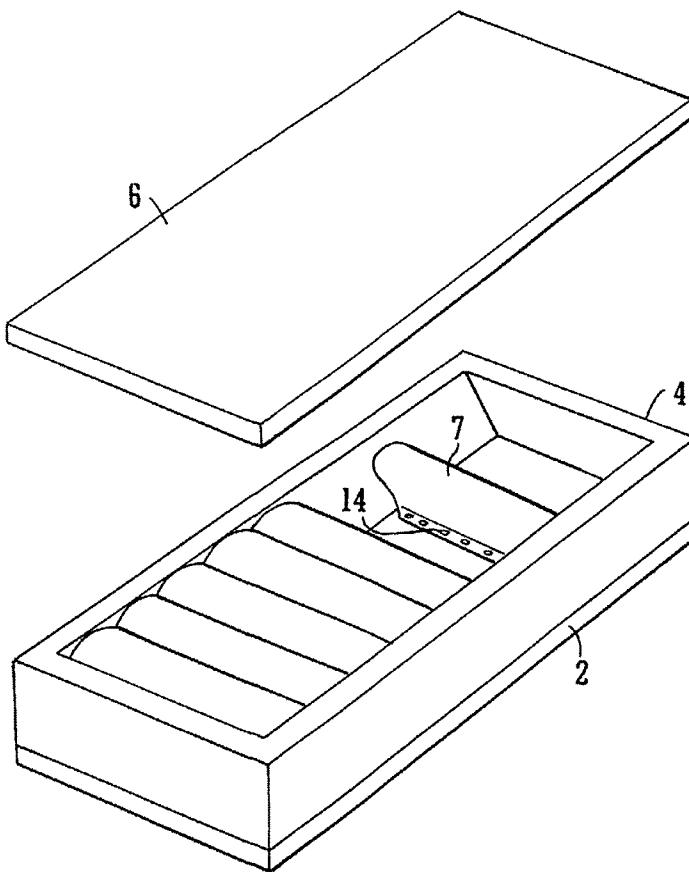
(74) Agent: **THOMSON, Paul, A.; Potts, Kerr & Co., 15 Hamilton Square, Birkenhead, Merseyside CH41 6BR (GB).**

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,

[Continued on next page]

(54) Title: MATTRESS OR LIKE BODY SUPPORTING DEVICE



(57) Abstract: The mattress or like body supporting device comprises an upper cover (6), a base (2) and wall members (4). Intermediate the cover and base there is provided a plurality of inflatable cells or chambers (7), each inflatable chamber (7) being connectable to a source of pressurised fluid or a pump, control means (20) being provided for selectively inflating and/or deflating two or more of the inflatable chambers independently of one another.

WO 03/024380 A1



TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

MATTRESS OR LIKE BODY SUPPORTING DEVICE

The present invention relates to a mattress or like device for supporting a body and more particularly to a mattress, pillow or cushion with independently inflatable cells or chambers.

Known mattresses usually comprise internal springs or sometimes are provided with air or water filled cores. Such mattresses are usually of a predetermined, constant firmness across their supporting surface and do not provide even body support. The lighter regions of the body, such as the heels, legs and upper trunk, are subjected to the same supporting pressure as the heavier regions, such as the hips, which creates discomfort with little or no deformation of the bed surface beneath the lighter regions of the body and considerable deformation of the bed surface beneath the heavier portions. Such mattresses can cause particular discomfort in persons suffering from back or neck injuries.

Furthermore, known mattresses lead to the compression of tissue in certain regions of the body where localised pressure points occur, leading to decubitis ulcers (commonly known as bed sores) in persons who lack the ability to move themselves to relieve such pressure or who are confined in bed for a prolonged period of time. Bed sores occur where compression of the tissue restricts the flow of blood thereto such that, unless the body is moved to relieve the pressure on said tissue and restore the blood supply, parts of the tissue die and become ulcerated.

According to the invention there is provided a mattress or like body supporting device comprising an upper surface, a lower surface and, intermediate the upper and lower surfaces, a plurality of inflatable cells or chambers, each inflatable chamber being connectable to a source of pressurised fluid or a pump, control means being provided for selectively inflating and/or deflating two or more of the inflatable chambers independently of one another.

Preferably said mattress comprises a plurality of zones or regions, the inflatable chambers in each zone or region being in fluid communication with every other chamber in the same zone or region to allow fluid to pass between chambers in a respective zone or region whereby the pressure in each chamber in a respective zone or region can be equalized and the control means can selectively inflate or deflate all of the chambers in a single zone or region simultaneously.

By varying the pressure or amount of fluid in the chambers in each zone or region of the mattress, the mattress can be adjusted to provide maximum even body surface contact with the mattress surface, thus minimising the interface pressure between the surface of the mattress and any part of the body, avoiding localised pressure points and providing increased comfort while reducing the likelihood of bed sores.

In a preferred embodiment of the invention at least the upper surface of the mattress is permeable to air and the mattress is provided with a plurality of air outlets within the mattress structure, said air outlets being connectable to a supply of air such that a flow of ventilating air can be provided within the mattress in order to purge any moisture of perspiration from within the mattress, thus ensuring that the mattress remains fresh, healthy and comfortable. Patients who are at risk from developing bed sores can suffer from deteriorating skin conditions, which, particularly when combined with high temperatures, can result in excessive perspiration which can cause further deterioration and maceration of the skin with an increased risk of bed sores, skin shear and extreme discomfort.

The mattress according to the invention may also be provided with means for supplying a flow of air or ozone directly under the patients body via, as described in co-pending International Application, PCT/GB00/04477.

The supply of air connected to the air outlets within the mattress structure and/or the means for supplying a flow of air directly under the patients body may be provided with heating and/or cooling means to control the temperature of the air supply.

According to a further aspect of the invention there is provided a method of operating an inflatable mattress or other like body supporting device, said device comprising an upper surface, a lower surface and, intermediate the upper and lower surfaces, a plurality of inflatable cells or chambers, each inflatable chamber being connectable to a source of pressurised fluid or a pump, control means being provided for selectively inflating and/or deflating two or more of the inflatable chambers independently of one another, said method comprising the steps of:-

- a) placing a patient on the mattress;
- b) releasing air from each inflatable chamber, preferably until said patient contacts one or more sensing means within the mattress in order to determine the position of the patient on the mattress;
- c) inflating one of said inflatable chambers or a group of said inflatable chambers for a predetermined period;
- d) recording the pressure in said one or more inflatable chambers;
- e) determining the weight of the region of the patient's body resting on said one or more inflatable chambers by comparing the pressure reading with a built in table or graph of patient weight to air pressure;
- f) repeating steps c) to e) for each of the remaining inflatable chambers or groups of inflatable chamber and;
- g) adjusting the pressure in each inflatable chamber or group of chambers to a pre-determined comfort pressure for the recorded weight of the region of the patient's body resting on each chamber or group of chambers in the mattress.

The present invention will be described further, by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is an exploded perspective view of a mattress according to the invention;

Fig. 2 is a sectional view through the mattress taken transverse to the longitudinal axis of the mattress;

Fig. 3 is a sectional view of the mattress taken along the longitudinal axis of the mattress;

As shown in the drawings, the mattress comprises a shallow box like structure defined by a base member 2, wall members 4 and an upper cover member 6, each formed from a flexible foam material which is permeable to air. Within the box like structure are arranged several inflatable cylindrical air cells 7 or chambers arranged transversely across the mattress. The entire structure is encased in a breathable fabric cover 8 (omitted in Fig. 1). A pump 10 is provided for inflating the air cells 7.

The mattress is divided into a number of zones, the air cells 7 of the mattress in each zone being pneumatically connected together to operate at a common pressure. The number of zones can be selected according to the requirements of the user for which the mattress is intended. In the present example three separate zones A,B,C are provided, although more or less zones could be provided.

The air cells 7 in each zone A,B, or C are connectable to the pump 10 via a respective solenoid valve 11,12,13 associated with each zone A,B,C, such that air can be selectively added to or removed from all of the cells 7 in each zone simultaneously. The arrangement of the cells 7 in each zone, the solenoid valves 11,12,13 and the pump 10 and the interconnecting air passages is such that the pressure and/or volume of air in each group of cells 7 in each zone A,B, or C of the mattress can be selectively varied to produce the desired level of support and/or firmness in each zone of the mattress such that all parts of the body are allowed to sink into the mattress surface and be

evenly supported by the respective zones, the air pressure within each group of cells 7 defining each zone of the mattress being adjusted to be suitable for supporting the particular mass of the region of the body resting thereon.

A series of mattress ventilating air outlets 14 are provided adjacent the lower region of each air cell 7, each air outlet 14 communicating with a supply line 15 connected to the pump 10 via a solenoid valve (not shown) to provide a ventilating flow of air within the mattress in order to purge any stale air, moisture or perspiration from within the mattress. Alternatively, a further pump or other source of pressurised air might be provided for the mattress ventilating air outlets. By separating the air outlets 14 from the cells 7 the air pressure in the cells 7 can be maintained when the pump 10 is inactive.

One or more micro-climate control pads 16 (not shown in Fig. 1), as disclosed in co-pending International Application PCT/GB00/004477, are provided beneath the fabric cover 8 of the mattress, or may be affixed to apertures in the fabric cover 8, for supplying a flow of air (or possibly a mixture of air and ozone) directly to the skin of the person laid on the mattress in order to control the humidity and/or temperature of the air at the interface between the skin of the person and the mattress. An air pump is provided for supplying a flow of air to the micro-climate control pads 16, which may be the same air pump 10 for supplying a flow of air to the air outlets 14, connected to a set of changeover valves and a humidity detector or sensor. Preferably, the air pump will be able to draw a vacuum, as well as be able to deliver a positive pressured air supply to the micro-climate control pads 16.

The operation of the inflatable air cells 7, the mattress ventilating air outlets 14 and the microclimate control pads 16 is controlled by an electronic control unit 20. A hand control 21 is connected to the control unit for manual control of the apparatus. A pressure sensor (not shown) is associated with each group of air cells 7 in each zone, each pressure sensor being connected to the

control unit 20 allowing the control unit to monitor the pressure in the air cells 7 in each zone of the mattress.

The pump 10 may be integrated with a peltier refrigeration system (not shown) for cooling the flow of air supplied to the air outlets 14 and/or the micro-climate control pads 16. Alternatively, heating means may be provided for controlling the temperature of the air supplied to the air outlets 14 and/or the micro-climate control pads 16.

The electronic control unit 20 may also be connected to the refrigeration system or heating means, if provided, and may be associated with temperature sensors provided on or within the mattress to control the temperature of the air supplied by the mattress ventilating air outlets 14 and/or the microclimate control pads 16.

When the control unit 20 is operated, the air pump connected to the micro-climate control pads 16 will start after a timed period. At the same time, the changeover valves will be switched on for a very short period to a sampling cycle such that a small sample of air will be drawn from the surface of the micro-climate control pads 16. This sample of air is passed over the humidity detector 18 such that the humidity level therein can be analysed. If the sample is normal, that is, if the level of humidity is deemed acceptable, then the system will go into a dormant monitoring cycle of timed intervals between sample analysis on a continuous basis. If the level of humidity is deemed unacceptable, then the control unit 20 changes over to the valve system, and fresh air, or treated air, from the pump is fed micro-climate control pads 16, thereby reducing the level of humidity and perspiration, i.e. adjusting the climatic conditions between the person and the surface of the mattress. After a predetermined time period, the sampling cycle described above tests the humidity level once again and the automatic cycle continues.

Manual operation of the control unit 20 will be now be described. When the power is switched on the system is in static mode. A person is laid on the bed and the hand control 21 is operated to adjust the air pressure in the air cells 7 in each zone A,B or C of the mattress to the desired level. For each zone A,B, or C of the mattress (and its corresponding group of air cells 7) there is an inflate button and a deflate button. The inflate button activates the pump 10. At the same time the solenoid valve 11,12 or 13 associated with the selected group of air cells 7 is opened. When the inflate button is released the solenoid valve 11,12 or 13 associated with the selected group of air cells is closed but the pump 10 continues to operate for a predetermined period of time, governed by a timer circuit, and the solenoid valve associated with the mattress ventilating air outlets 14 is opened to ventilate the mattress. Operation of the deflate button opens the solenoid valve 11,12 or 13 associated with the selected group of air cells without operating the pump 10 and opens a solenoid valve 17 associated with an outlet or vent port 18, such that the air is permitted to escape from the selected group of air cells 7 to reduce the pressure therein. Each time the inflate or deflate button is released the control unit 20 records the air pressure within the selected group of air cells 7 and subsequently monitors the air pressure therein, automatically adding or removing air from the selected group of cells 7 to maintain the pressure at the selected value.

The control unit 20 may also provide a fully automatic adjustment system to automatically obtain the optimum support pressure for each region of the body of a patient. The automatic adjustment system is particularly advantageous where the mattress is used in hospitals or other nursing environments to support an unconscious or immobile patient. To activate the automatic adjustment system a patient is placed on the mattress and a reset button is depressed on the hand control 21. The control unit 20 opens the solenoid valves 11,12,13 and 17 to release air from each group of air cells in each zone of the mattress until the patient contacts position sensors 22,23,24 provided beneath the air cells 7 such that the position of the patient on the

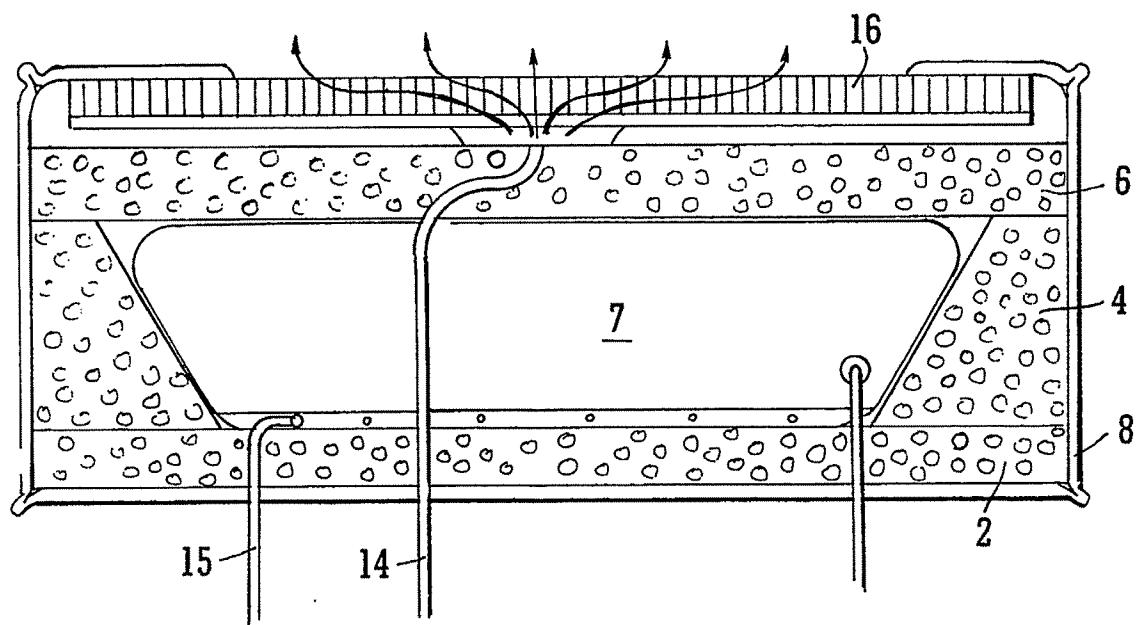
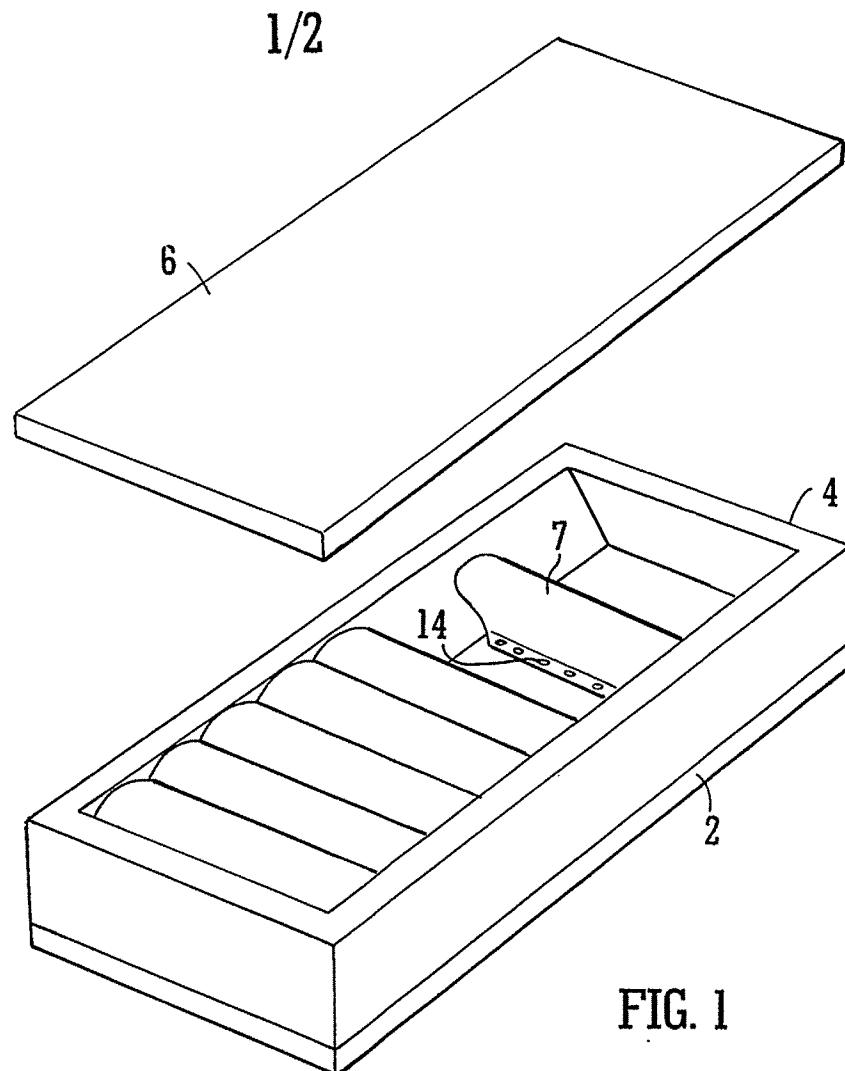
bed can be determined. The solenoid valves 11,12,13 associated with each zone of the mattress and the solenoid valve 17 associated with the outlet port, are then closed, with the exception of the solenoid valve 11,12 or 13 associated with the group of the air cells 7 in a first zone of the mattress, and the pump 10 is activated for a predetermined period of time whereupon the pressure of the air within said group of cells is recorded to determine the weight of the region of the patient's body resting on the selected zone of the mattress by comparing the pressure reading with a built in table or graph of patient weight to air pressure. The process is repeated for each of the remaining zones of the mattress. Once this process has been completed for the cells 7 in each zone of the mattress, the air cells 7 in each zone are automatically inflated to a pre-determined comfort pressure for the recorded weight of the region of the patient's body resting on each zone of the mattress.

While the invention has been described in relation to a mattress, the invention can equally be applied to any other body supporting device, such as a pillow or a cushion, the supporting surfaces of a chair or wheelchair or any other body supporting device having an inflatable supporting surface, wherein selective and independent inflation of separate zones of the supporting surface of the device can provide increased comfort for the user.

CLAIMS

1. A mattress or like body supporting device comprising an upper surface, a lower surface and, intermediate the upper and lower surfaces, a plurality of inflatable cells or chambers, each inflatable chamber being connectable to a source of pressurised fluid or a pump, control means being provided for selectively inflating and/or deflating two or more of the inflatable chambers independently of one another.
2. A mattress or like body support as claimed in claim 1 wherein said mattress comprises a plurality of zones or regions, the inflatable chambers in each zone or region being in fluid communication with every other chamber in the same zone or region to allow fluid to pass between chambers in a respective zone or region whereby the pressure in each chamber in a respective zone or region can be equalized and the control means can selectively inflate or deflate all of the chambers in a single zone or region simultaneously.
3. A mattress or like body support as claimed in any preceding claim, wherein at least the upper surface of the mattress is permeable to air and the mattress is provided with a plurality of air outlets within the mattress structure, said air outlets being connectable to a supply of air such that a flow of ventilating air can be provided within the mattress in order to purge any moisture of perspiration from within the mattress, thus ensuring that the mattress remains fresh, healthy and comfortable.
4. A mattress or like body support as claimed in claim 3, wherein means for supplying a flow of air or ozone directly under the patients body are provided.

5. A mattress or like body support as claimed in claim 3 or claim 4, wherein the supply of air is provided with heating and/or cooling means to control the temperature of the air supply.
6. A method of operating an inflatable mattress or other like body supporting device, said device comprising an upper surface, a lower surface and, intermediate the upper and lower surfaces, a plurality of inflatable cells or chambers, each inflatable chamber being connectable to a source of pressurised fluid or a pump, control means being provided for selectively inflating and/or deflating two or more of the inflatable chambers independently of one another, said method comprising the steps of:-
 - a) placing a patient on the mattress;
 - b) releasing air from each inflatable chamber, preferably until said patient contacts one or more sensing means within the mattress in order to determine the position of the patient on the mattress;
 - c) inflating one of said inflatable chambers or a group of said inflatable chambers for a predetermined period;
 - d) recording the pressure in said one or more inflatable chambers;
 - e) determining the weight of the region of the patient's body resting on said one or more inflatable chambers by comparing the pressure reading with a built in table or graph of patient weight to air pressure;
 - f) repeating steps c) to e) for each of the remaining inflatable chambers or groups of inflatable chamber and;
 - g) adjusting the pressure in each inflatable chamber or group of chambers to a pre-determined comfort pressure for the recorded weight of the region of the patient's body resting on each chamber or group of chambers in the mattress.



2/2

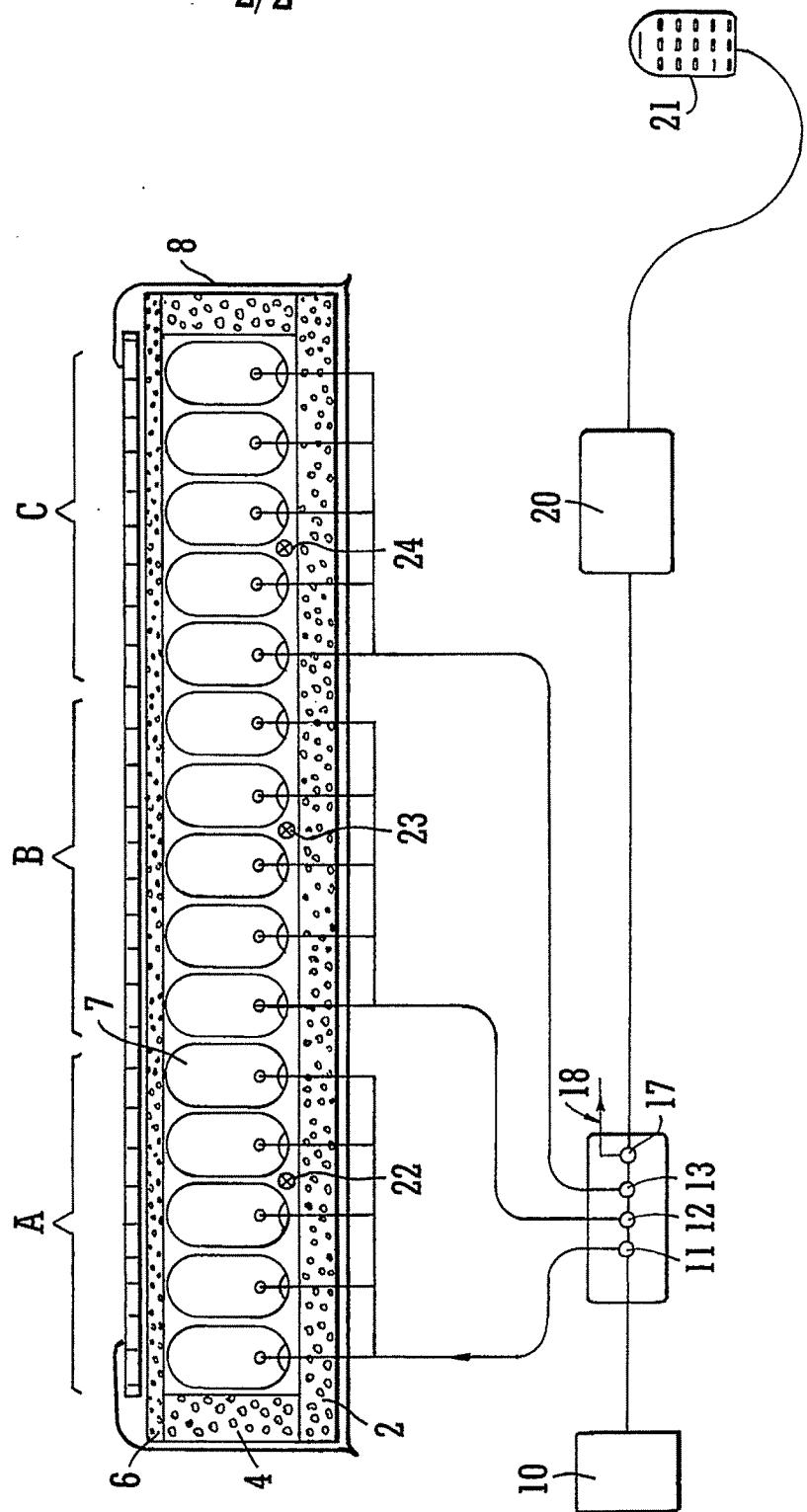


FIG. 3

INTERNATIONAL SEARCH REPORT

Inte Application No

PCT/GB 02/04233

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61G7/057

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 03625 A (MARI & CCARON) 27 January 2000 (2000-01-27) the whole document ----	1-5
X	WO 93 24088 A (CALDWELL VERA ; CALDWELL KENNETH (GB)) 9 December 1993 (1993-12-09) the whole document ----	1-5
X	WO 00 24353 A (TAYLOR GEOFFREY LOCKE ; MENSCHING KERRY J (US); STOLPMANN JAMES R () 4 May 2000 (2000-05-04) the whole document ----	6



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

° Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

25 November 2002

Date of mailing of the international search report

02/12/2002

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Godot, T

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 02/04233

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB 02 04233

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-5

Mattress comprising an upper surface permeable to air

2. Claim : 6

Method of operating an inflatable mattress using sensing means

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 02/04233

Patent document cited in search report	Publication date		Patent family member(s)	Publication date
WO 0003625	A 27-01-2000	HR AU CZ EP WO	980391 A1 1884799 A 20001316 A3 1037582 A2 0003625 A2	31-12-2000 07-02-2000 12-12-2001 27-09-2000 27-01-2000
WO 9324088	A 09-12-1993	AU AU DE DE EP WO GB	681084 B2 4337693 A 69327872 D1 69327872 T2 0643572 A1 9324088 A1 2267217 A , B	21-08-1997 30-12-1993 23-03-2000 05-10-2000 22-03-1995 09-12-1993 01-12-1993
WO 0024353	A 04-05-2000	AU BR CA EP JP WO	1328400 A 9914920 A 2346207 A1 1123074 A1 2002528175 T 0024353 A1	15-05-2000 10-07-2001 04-05-2000 16-08-2001 03-09-2002 04-05-2000